Kennedy Space Center

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Large Diameter Auger Remediation at Wilson Corners Kennedy Space Center

Presented to:

2015 Florida Remediation Conference

By:

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Rosen Center, Orlando

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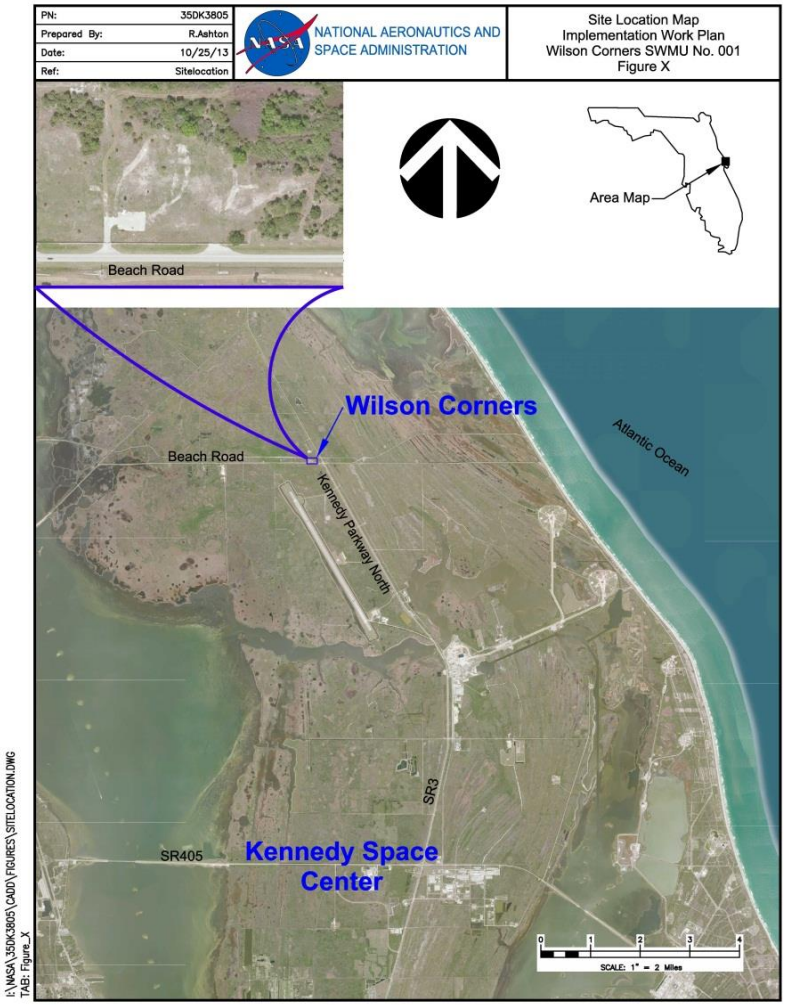
- Location
  - KSC is located with the Cape Canaveral barrier island and tidal inlet system.
- Land area
  - Covers 140,000 acres (6,000 acres for center operations); land cover mostly urban/developed & pine flatwoods.
  - 92,000 acres of the Merritt Island Wildlife Refuge
    - 310 species of birds, 25 mammals, 117 fishes, and 65 amphibians or reptiles.
  - Wetlands represent ~¼ KSC property

Wilson Corners

- Site of a general store before acquisition by NASA
- Became the Propellants System Cleaning Laboratory in 1963, decommissioned in 1973
- National Park Service used from 1974 to 1987
- Issues with the site were first discovered in 1977 during routine analysis of drinking water from on-site well



Propellants System Cleaning Laboratory 1963-74

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Site History

- Assessment/investigations dating back to mid 1980s
- Previous Remedial Actions
  - 1989-1999: Pump & Treat system for plume containment
  - 2003-2004: Excavated shallow (up to 14 feet below land surface [ft BLS]) soil (organic hardpan) and treated with low temperature thermal desorption
  - 2004-2007: Focused treatment of central source area via chemical oxidation, biostimulation and pumping (targeted 40 to 45 ft BLS)
- Approximately 22,000+ lbs of TCE mass have been removed via previous corrective actions (not considering mass that was reductively dechlorinated or oxidized)
- 2005-Present: Overall dissolved groundwater plume monitoring and reporting, well installations, and additional groundwater investigations

Site Conditions

- Groundwater
  - Contaminants of concern: Chlorinated Volatile Organic Compounds (CVOC)
  - Area with concentrations greater than groundwater cleanup target levels (GCTLs) is ~20 acres
  - Area with concentrations greater than natural attenuation default concentrations (NADCs) is ~8 acres
  - Hot Spot 1 Area is 0.33 acres

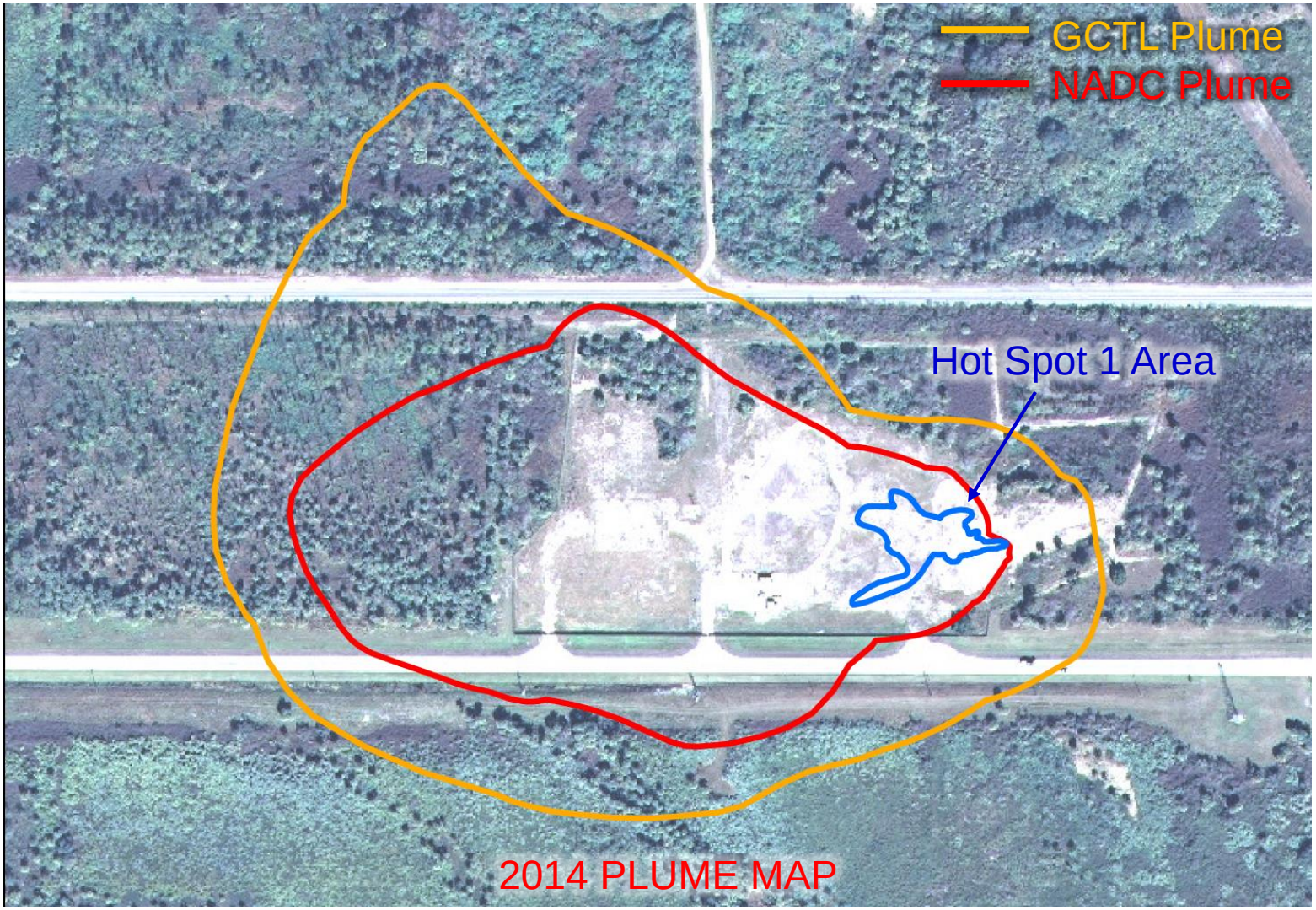
Site Conditions

- Lithology is dominated by sand with varying amounts of organics, silt, shell, and clay
  - Semi-confining unit ~36 feet below land surface
- Depth to groundwater typically 3-6 feet below land surface
  - Groundwater classified as potential drinking water

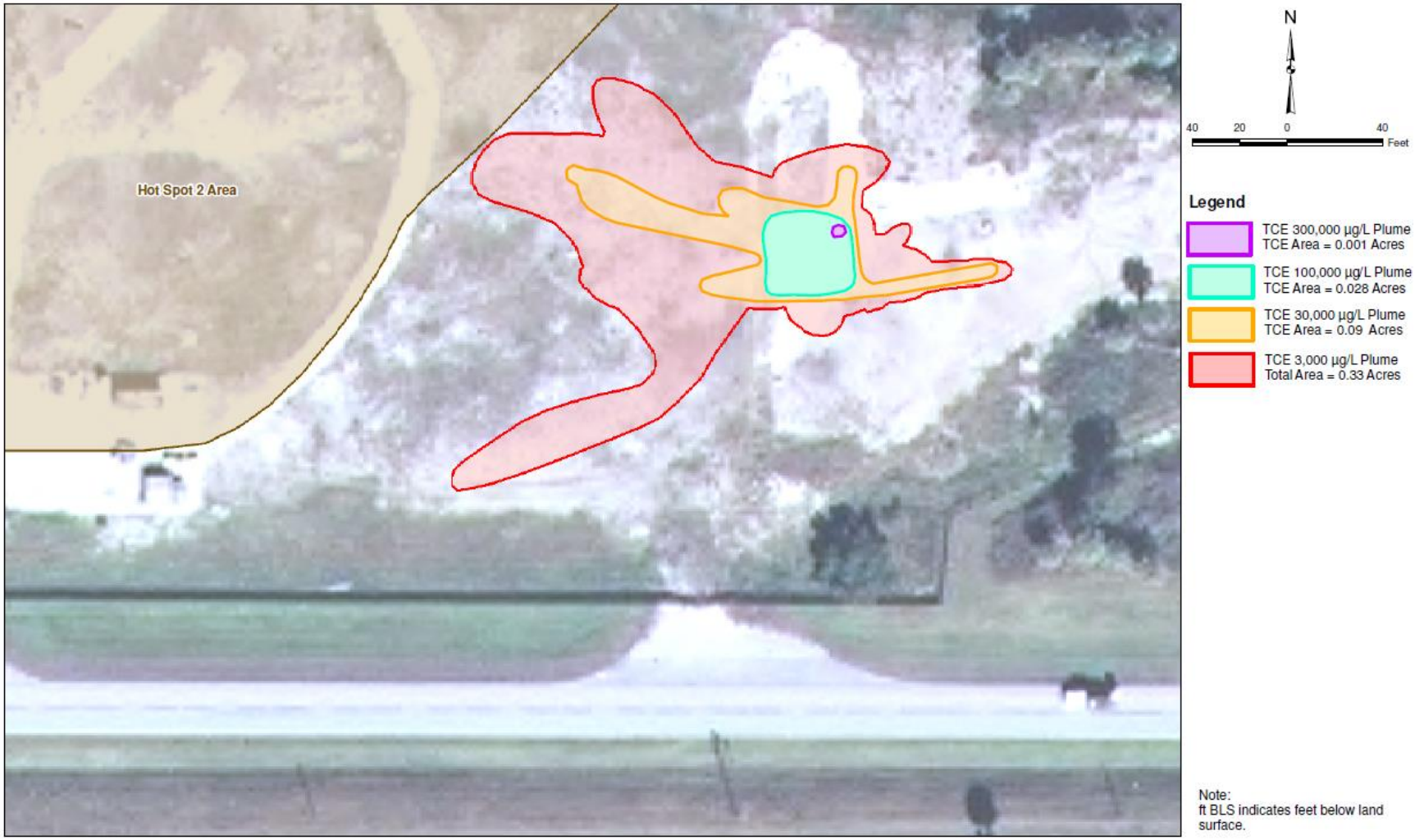
Sandy soils with shells

Silty soils transitioning to clay

Groundwater Plume



Hot Spot 1


Hot Spot 2 Area
N
40 20 0 40
Feet
Legend
TCE 300,000 µg/L Plume
TCE Area = 0.001 Acres
TCE 100,000 µg/L Plume
TCE Area = 0.028 Acres
TCE 30,000 µg/L Plume
TCE Area = 0.09 Acres
TCE 3,000 µg/L Plume
Total Area = 0.33 Acres
Note:
ft BLS indicates feet below land surface.

Hot Spot 1
East-West Cross Section

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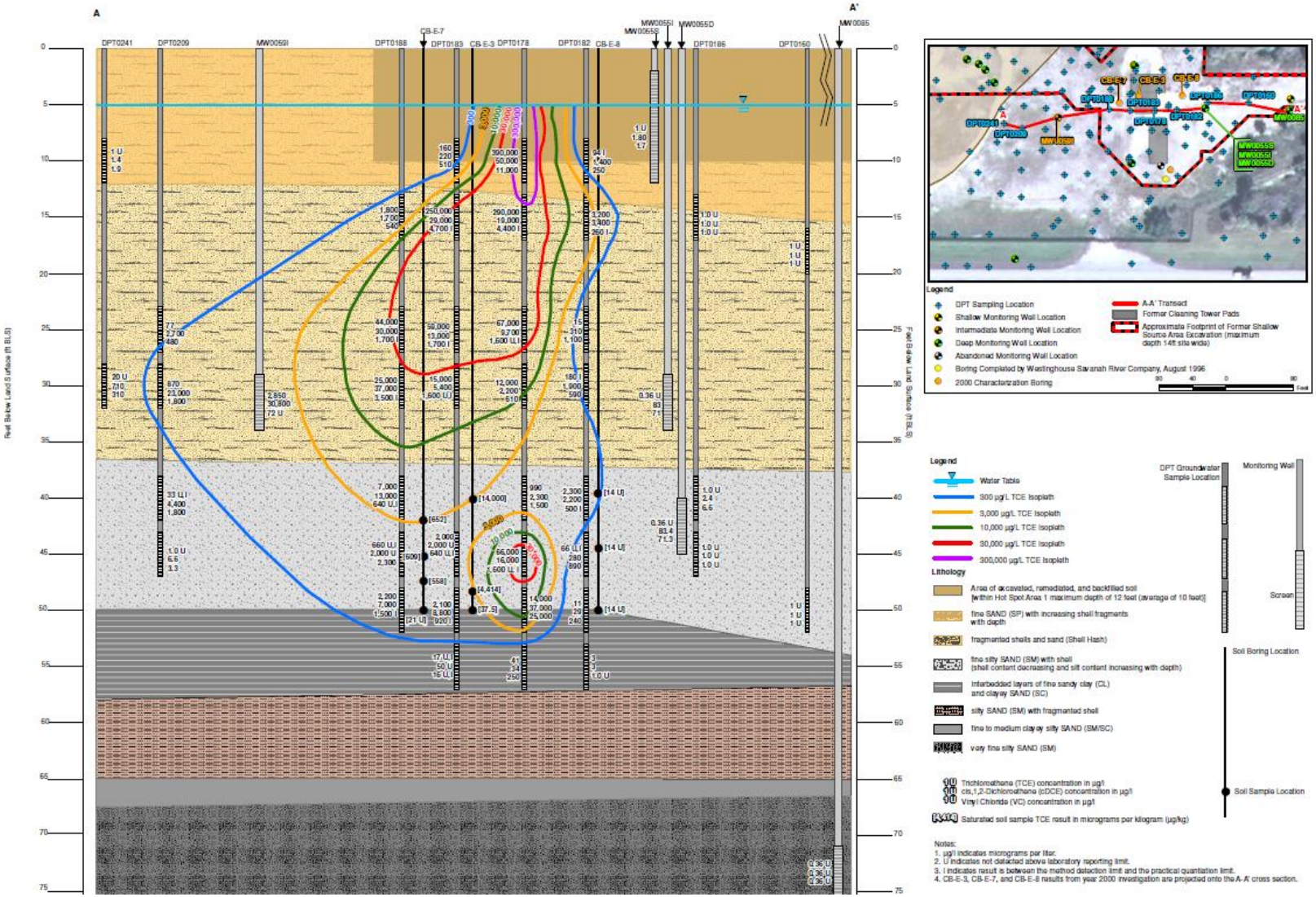

Hot Spot 1
North-South Cross Section

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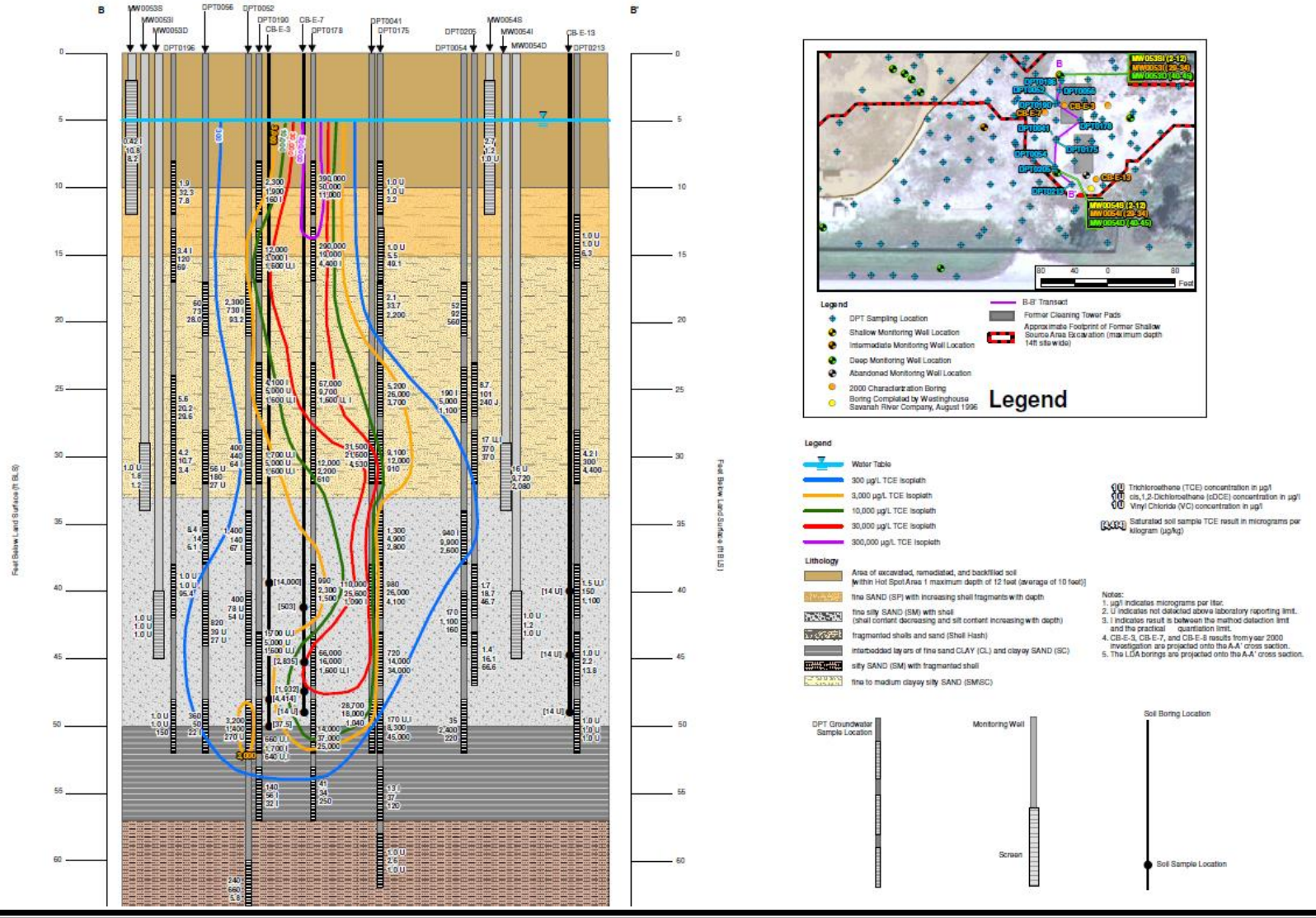


Remedy Selection for Hot Spot 1

- Soil mixing with steam and zero valent iron (ZVI) injection
  - 8 ft diameter auger mixes a column of soil while delivering steam and hot air to the subsurface to volatilize contaminants
  - Borehole is covered by a shroud at the surface with an applied vacuum to contain vapors for treatment
  - ZVI injected on the way up as a polishing step


Boilers


Containment shroud with auger

Remedy Selection for Hot Spot 1

- Robust real time data acquisition to customize treatment
  - Provides concentrations of contaminants of concern at 4 minute intervals
  - Data used to determine if cell needs to be treated longer, deeper, or if step-out treatment is needed


Gas Chromatographs

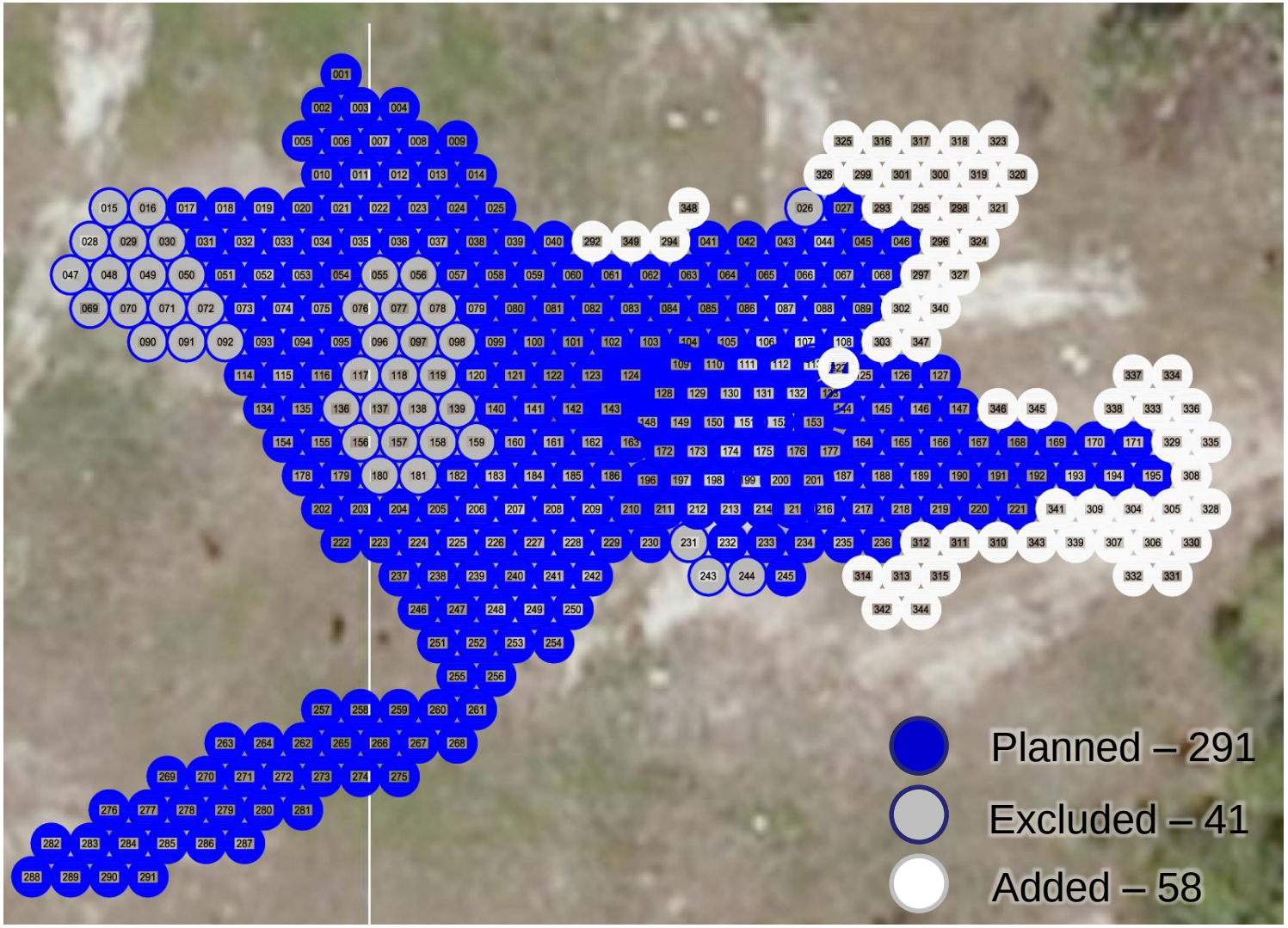
Iron Mixing Station

Treatment Summary

- Area treated through a series of cells in a honeycomb pattern
- 308 cells treated between September 2014 to February 2015
- Volume treated = 24,535 cubic yards
- Treatment depths varied from 40 to 58 ft bls
- Performance monitoring – 1st event scheduled for October 2015

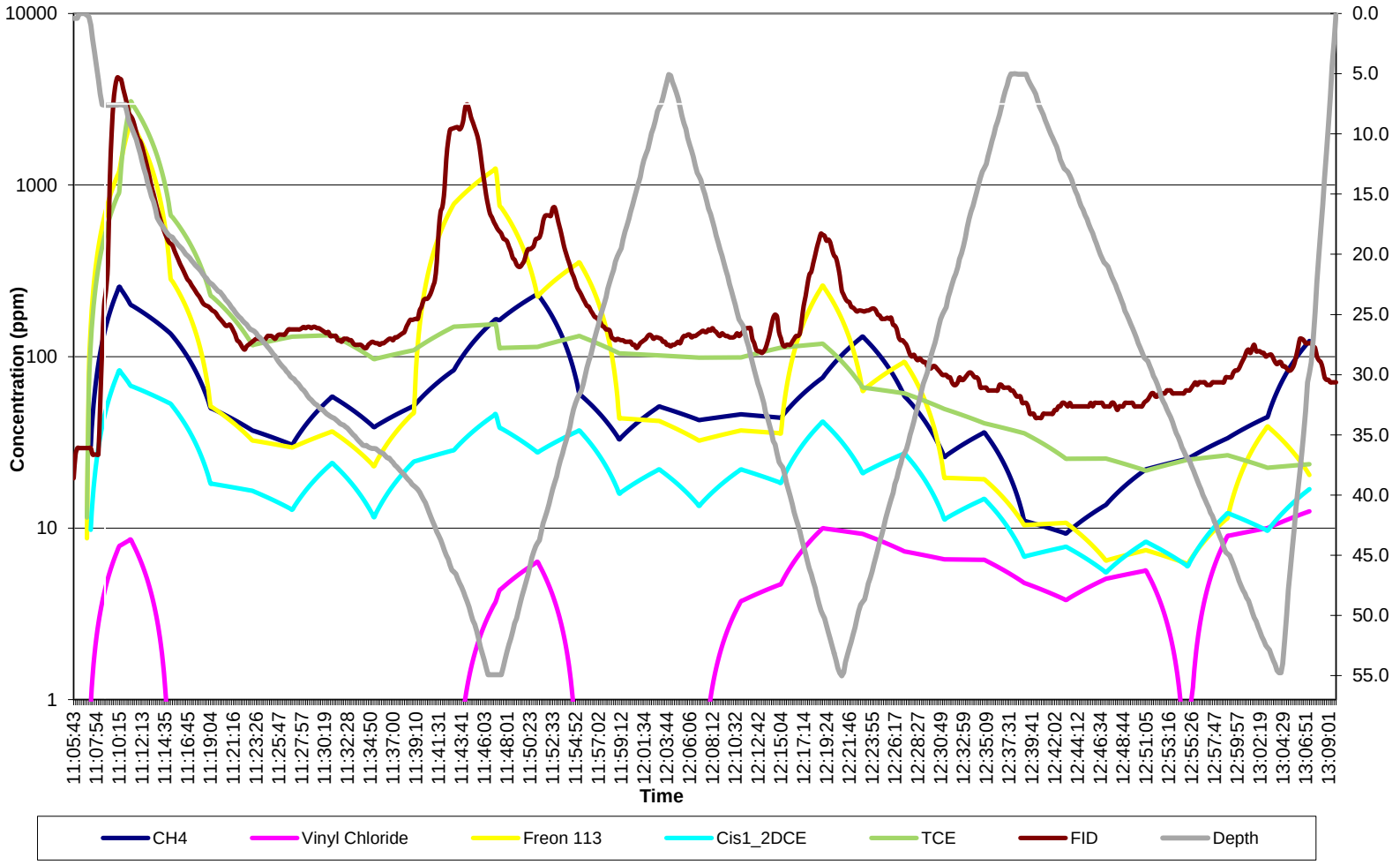
Crane with shroud

Treatment Figure



Treatment Data

Cell 217



Lessons Learned - Planning

- Items to consider including in the treatment protocol
  - Clarify the role of methane in the decision-making process
    - FID response determined ZVI dosing
    - Require CH4 calibration
  - Clarify the role of other COCs such as Freon 113
    - Freon 113 was not a targeted treatment compound, but accounted for the majority of the mass removed
  - Establish conditions from when deviations from the protocol should be considered
    - ZVI dosage
    - Steam pounds per hour
    - Steam and shroud temperature
  - Set the GC detection limit low enough that contaminant levels less than the project cleanup goals can be recognized

Lessons Learned – Mixing Tool Damage

- It is important to remove all subsurface debris from treatment area
- Encountered unknown buried debris which caused damage to mixing tool


Subsurface debris


Damaged auger

Lessons Learned – Start Up

- Choose test cells in varying levels of contamination to prove-out equipment or instrumentation to gauge how FID and GC's are going to react
- Co-locate select test cells and historical DPT locations for data comparison purposes
  - Keeping in mind groundwater data and vapor/air stream GC results cannot easily be directly compared

Lessons Learned – Data Collection

- To allow for greater data acquisition flexibility, consideration should be given to third party data acquisition manager/oversight
- Stainless steel tubing should be used to collect FID and GC samples due to its inertness
  - Copper lines may react with chlorinated compounds, masking concentrations
- Gather additional GC data by:
  - Adjusting GC operating conditions to more rapidly cycle instruments
  - Employ additional GC's to allow for greater data acquisition flexibility
  - Account for GC lag time (approximately 6-7 seconds for sample air to reach instrumentation).

Lessons Learned – Data Collection

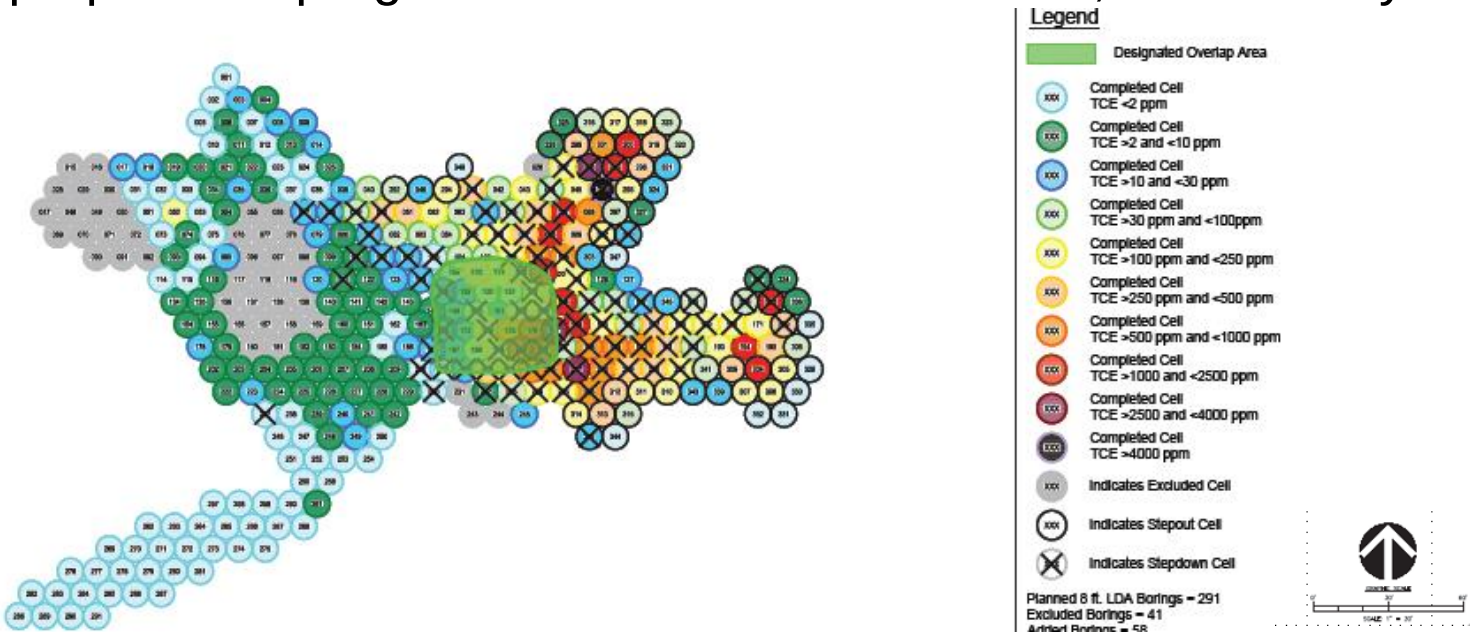
- Intermittently collect vapor stream samples for fixed lab analysis (TO-15)
  - Results used to gauge on-site GC data acquisition
  - Evaluate non-target analytes


Gas Chromatographs


Data Output

Lessons Learned - Implementation

- Even with high resolution site characterization at DNAPL sites you may find mass in areas not suspected
- If high concentration of TCE are anticipated and ZVI has been applied to adjacent cells, there is the possibility of hydrogen generation
  - Be prepared to purge CH4 from under the shroud, if necessary



Questions